3.0 FACILITY DESCRIPTION

The description of the facility presented in this section is based primarily on information contained in the 1995 Final Environmental Impact Statement (EIS) that evaluated disposition and reuse of JPG (U.S. Army 1995a), the remedial investigation/feasibility study (RI/FS) [Rust Environment and Infrastructure (E&I) 1994, 1998; Montgomery Watson Harza (MWH) 2002], and information obtained through internet searches. The discussion of land use north of the firing line is based on information from the Memorandum of Agreement (MOA) [see Appendix A] between the U.S. Army, USAF, and the FWS (U.S. Army 2000).

The site location and description are provided in Section 3.1. Information on the population distribution and current and future land uses is detailed in Sections 3.2 and 3.3. The remaining sections address meteorology and climatology (Section 3.4), geology and seismology (Section 3.5), surface water and groundwater hydrology (Sections 3.6 and 3.7), natural resources (Section 3.8), and ecology/endangered species (Section 3.9).

3.1 SITE LOCATION AND DESCRIPTION

JPG occupies approximately 55,264 acres (224 km^2) within parts of north-central Jefferson, southwestern Ripley, and southeastern Jennings counties in the southeastern portion of the state of Indiana. The firing line divides the JPG into two portions, approximately 51,000 acres (206 km^2) north of the firing line and 4,000 acres (16.1 km^2) south of the firing line. The DU Impact Area, consisting of approximately 2,080 acres (8.4 km^2), is located within the 51,000-acre (206-km^2) area north of the firing line. The DU Impact Area is approximately 17,280 ft (5,270 m) long and 5,240 ft (1,600 m) wide. The southern boundary of the DU Impact Area is slightly south of C Road while the northern boundary is at F Road. The western and eastern boundaries are at Morgan and Wonju Roads, respectively.

The nearest population center is the City of Madison, Indiana, which has a population of 12,004 (U.S. Census Bureau 2000), approximately one-third of the population of Jefferson County. The location of the site and nearby communities is shown in Figure 2-1. Major metropolitan areas include Louisville, Kentucky, approximately 60 miles (96 km) southwest; Cincinnati, Ohio, approximately 75 miles (121 km) northeast; and Indianapolis, Indiana, approximately 100 miles (161 km) north–northwest. The JPG is located 8 miles (13 km) north of the Indiana-Kentucky border (SAIC 1997a).

The natural topography of the site is rolling wooded and grassy areas with elevations ranging from 850 ft (260 m) to 930 ft (285 m). Most relief is due to stream incision. In addition to the natural features, there are several munitions-excavated trenches. There is an interior road system suitable for off-road vehicles. A fence system (i.e., a 7-ft (1.8-m) chain-linked fence topped with V-shaped, 3-strand barbed wire) is maintained around the perimeter of the area north of the firing line. A barricade system (high-security locks with swing gates) is maintained for all roads providing direct access to the DU Impact Area. Several historic structures stand north of the firing line: Oakdale Schoolhouse, Old Timbers Lodge, and four stone-arch bridges (SAIC 1997a). A diagram of the site is presented in Figure 2-2.

The property surrounding the site is predominantly farmlands, woodlands, and rural residential areas (SAIC 2002a). Public water from a municipal system, or deep wells, is used by nearby communities or individuals. Well depths range from 50 ft (15 m) to 300 ft (90 m) and are completed in limestone formations underlying the site (Rust E&I 1994, 1998; MWH 2002).

Prominent water pathways on-site are Big Creek, Graham Creek, Otter Creek, Harberts Creek, and several smaller creeks that are sub-basins of the Muscatatuck River, White River, and the Ohio River. Surface water drainage is generally from the northeast to the west and southwest. Old Timbers Lake, a man-made lake from the impoundment of Little Otter Creek, is the primary lake. Old Timber's Lake runs generally north to south and is located in the northeast portion of JPG. Krueger Lake, located in the southeastern corner of JPG, is a result of the impoundment of Harbert's Creek. Several smaller ponds are on the site. The Ohio River is located 8 miles (13 km) south of the site.

3.2 POPULATION DISTRIBUTION

The DU Impact Area is located in Jefferson County, which has a population of approximately 31,705 people. The county has undergone approximately 6.4 percent growth from 1990 to 2000, based on 1990 and 2000 census data (U.S. Census Bureau 2000). The nearest population center is the city of Madison, Indiana, which has a population of 12,004 people, approximately one-third of the Jefferson County population. The 2000 census data indicate that approximately 85,782 people live in Jefferson, Jennings, and Ripley Counties combined, covering a radius of more than 15 miles (24 km) from the DU Impact Area. The population in Jefferson, Jennings, and Ripley Counties is projected to increase an average of 2.8, 5.0, and 4.1 percent, respectively, every 5 years to the year 2020, based on the 1990 census data (U.S. Census Bureau 2000). The nearest residences are in Buildings 205 and 241, which are due north of the family housing area in the Cantonment Area along the firing line fence. These structures are about 0.5 miles (.81 km) closer to the DU Impact Area than the family housing; therefore, the closest residence is about 2 miles (3.2 km) from the southern boundary of the DU Impact Area (Knouf 2002). The family housing area is approximately 2.5 miles (4.0 km) from the southern border of the DU Impact Area. Approximately 100 farmhouses and other dwellings are located within 1 mile (1.61 km) of JPG's southern border or almost 4 miles (6.4 km) from the southern border of the DU Impact Area (MWH 2002). Table 3-1 indicates the population trends in the vicinity of JPG.

The average minority population in the State of Indiana is 12.5 percent. The minority population within Jefferson, Jennings, and Ripley Counties averages approximately 2.7 percent of the total population in these counties as shown in Table 3-1. The minority population within the immediate area [i.e., a 6.4-km (4-mile) radius of the installation] is less than 0.3 percent of the population living within that radius. The highest median income of $36,854 occurs in Ripley County. The lowest median income of $32,121 occurs in Jennings County. Approximately 12 percent of people residing in Jefferson County have incomes below poverty level [U.S. Department of Agriculture (USDA) 1997], defined as an income of $17,650 for a family of four [U.S. Department of Health and Human Services (USDHHS) 2001].

3.3 CURRENT/FUTURE LAND USE

The majority of land surrounding JPG is rural agricultural. The adjacent land use has changed little since establishment of the installation in the 1940s and has been used predominantly for small family farms since the early 1800s. JPG is surrounded by several small rural towns. Approximately 100 farmhouses and other dwellings are located within 1 mile (1.6 km) of JPG's southern border (Rust E&I 1998; MWH 2002). The major local crops are tobacco, corn, and soybeans.

The FWS established the Big Oaks NWR in the area north of the firing line in June 2000. Under a negotiated MOA (Appendix A) between the U.S. Army, USAF, and the FWS, the Army will retain ownership of the land and the FWS will operate the Big Oaks NWR on a 25-year lease with 10-year renewal options. The Big Oaks NWR encompasses more than 50,000 acres (202 km^2) of grasslands, woodlands, and forests, including the DU Impact Area. The FWS restricts access to approximately 24,000 acres (97 km^2) of land within the refuge because of the occurrence of both UXO and DU.

Table 3-1. Population Trends Near Jefferson Proving Ground

Location	Compass Vector	Population			Population by Race				Household Income				
		2000 Population	% Change (1990–2000)	2020 Projected Population[c]	% White	% Black	% Asian	% Other	Median Income	% Under Poverty Level[d]	% Under $50K	% $50–$100K	% Over $100K
State of Indiana[a]	NA	6,080,485	9.7	6,481,489	87.5	8.4	1.0	3.1	$37,909	9.9	NA	NA	NA
Jefferson County[a]	NA	31,705	6.4	35,340	96.2	1.5	0.6	1.7	$33,630	11.6	NA	NA	NA
City of Madison[a]	S	12,004	NA	NA	94.6	2.4	0.8	2.2	$37,651	NA	68.6	25.9	5.6
Jennings County[a]	NW	27,554	16.5	33,404	97.5	0.7	0.3	1.5	$32,121	9.8	NA	NA	NA
City of North Vernon[b]	NW	20,144	NA	NA	98.3	1.1	0.3	0.2	$37,013	NA	70.1	24.9	5
Ripley County[a]	NNE	26,523	7.7	30,983	98.3	0	0.4	1.3	$36,854	9.7	NA	NA	NA
City of Versailles[b]	NE	4,145	NA	NA	99.5	0	0.3	0.2	$34,242	NA	71.3	22.9	5.8
4-Mile (6.4-km) Radius of DU Impact Area[e]	NA	6,943	NA	NA	99.7	0.2	0	0.1	NA	NA	NA	NA	NA

[a]Source: U.S. Census Bureau 2000.
[b]Source: CACI 2000.
[c]Calculated from 1990 census data (U.S. Census Bureau 2000).
[d]Source: U.S. Department of Agriculture (USDA) 1997.
[e]Number biased high (overestimates the actual population) because the census block groups used in the analysis cover an area of 282.9 mi^2 (732.8 km^2) instead of 50.3 mi^2 (130 km^2) [the area within a 4-mile (6.4-km) radius].
NA = Not applicable.

The Indiana ANG also operates a bombing range north of the firing line. The bombing range includes an approximately 50-acre (0.2-km^2), precision-guided munitions range, an approximately 983-acre (4-km^2) conventional bombing range, and approximately 5 acres (0.02 km^2) associated with the Old Timbers Lodge (Figure 2-2). These areas are excluded from the real estate permit for the refuge. When in use, the bombing ranges have large safety fans. FWS personnel and visitors are excluded from the bombing ranges (inclusive of the safety fan) during flight operations involving training munitions or laser energy (U.S. Army 2000).

To date, approximately 1,469 acres (6 km^2) located south of the firing line have been transferred for private, recreational, or commercial use. In addition, approximately 2,400 acres (9.8 km^2) south of the firing line are being leased to a local businessman. This property is used for light industrial, commercial, agricultural, and residential purposes. The fee title will be transferred as the parcel is remediated of ordnance and other contamination. Disposition of an additional approximately 300-acre (1.2-km^2) parcel south of the firing line and west of the airfield area (west of Tokyo Road and south of Woodfill Road) has not yet been determined.

3.4 METEOROLOGY AND CLIMATOLOGY

The climate at JPG is mid-continental with frequent changes in temperature and humidity because of the low- and high-pressure systems that routinely pass through the area and the occasional influx of warm, humid air from the Gulf of Mexico. During the summer, the temperatures average from the mid-70 to the mid-80 degrees Fahrenheit (°F) [21 to 27 degrees Celsius (°C)]. On average, the temperature exceeds 90°F (32.2°C) for 39 days a year. Winter temperatures generally range from 22 to 35°F (–5.6 to 1.7°C) [MWH 2002].

Thunderstorms with high rainfall intensities and damaging winds are common during the spring and summer months. Heavy fog, reducing prevailing visibility to ¼-mile (0.4 km) or less, occurs an average of 18 days a year. The prevailing wind direction is to the south with an average velocity of less than 10 miles (16 km) per hour (MWH 2002). The total annual precipitation is approximately 42 to 44 in. (107 to 112 cm), with nearly 50 percent occurring during the growing season from May to October. Precipitation is greater than or equal to 0.5 in. (1.3 cm) approximately 28 days per year. Table 3-2 presents climatological data for southern Indiana.

There are four weather stations located in Jefferson County, three of which are active (COOP ID 122184 and 125237 and WBAN 53814). These stations collect limited data (e.g., minimum/maximum temperature, precipitation, etc.) that may be accessed from the National Climatic Data Center (NCDC) [see http://www.ncdc.noaa.gov/]. Information on wind speed and direction at all heights is not available in this region. The closest location where related data are collected is Wilmington, Ohio [National Weather Service (NWS) 2002]. Wind speed and direction data may be obtained from Indianapolis, Indiana, and Louisville, Kentucky. Data for the 30-year period ending in 1990 from the Louisville International Airport are provided in Table 3-3 (NWS 2002). These values are consistent with those data reported in MWH (2002).

The FWS installed and began operation of a weather monitoring station within the Big Oaks NWR in April 2002. Typical data collected include rain, wind, temperature, and relative humidity. Seasonal or trend data are not available given the short duration the station has been operational.

Air monitoring stations are located at six locations in Jefferson County (Wilson Road, Bacon Ridge Road, K Road, Graham Road, Kent Hall-State Hospital, and Sunrise Golf course), which at various points in time were used to monitor for total suspended particulates, sulfur dioxide, nitrogen dioxide, and/or nitrous oxides. The Wilson Road station was the only active station in 2001, which monitored sulfur dioxide. This information is based on the U.S. Environmental Protection Agency's (EPA's) air pollution database, AIRS.

Table 3-2. Climatology of Jefferson Proving Ground

Month	Temperature[b]					Precipitation[c]				
				2 Years in 10 Will Have			2 Years in 10 Will Have			
	Average[a] (°F)	Average Maximum[a] (°F)	Average Minimum[a] (°F)	Maximum Higher Than[a] (°F)	Minimum Lower Than[a] (°F)	Average[a] (Inches)	Less Than[a] (Inches)	More Than[a] (Inches)	Average # of Days with 0.10 Inch or More[a]	Average Snowfall[a] (Inches)
January	33.0	42.0	24.0	67	-3	3.21	1.8	4.36	7.36	5.4
February	36.7	46.7	26.7	69	1	3.34	1.52	4.82	7	2.3
March	44.5	55.4	33.7	80	14	4.48	2.48	6.1	9	2.9
April	55.8	68.4	43.5	86	25	4.03	2.02	5.66	9	0.1
May	65.2	77.5	52.8	93	33	4.48	2.59	6.01	8	0
June	73.8	85.3	62.2	97	45	4.01	2.36	5.46	7	0
July	77.0	88.1	65.9	98	51	3.76	2.18	5.03	7	0
August	75.8	87.3	64.2	98	50	2.61	1.18	3.78	5	0
September	70.1	82.3	57.9	97	40	3.15	1.49	4.49	6	0
October	59.0	71.4	46.5	88	27	2.6	1.27	3.68	5	0
November	46.4	56.3	36.5	79	14	3.25	1.78	4.44	6	0.6
December	35.7	44.7	26.8	70	2	3.05	1.54	4.29	6	1.8
Average	56.1	67.1	45.1	—	—	—	—	—	6.8	1.09
Extreme	—	—	—	102	-5	—	—	—	—	—
Total	—	—	—	—	—	41.97	35.46	48.16	82	13.1

[a]Source: MWH 2002 (data recorded in the period 1951–1976 at Madison, Indiana).
[b]To convert from Fahrenheit to Celsius, subtract 32 and multiply by 5/9.
[c]To convert from inches to centimeters, multiply by 2.54.

Table 3-3. Average Monthly Wind Speed and Direction from 1960–1990, Louisville International Airport

Month	Wind Speed (miles per hour)[a]	Direction (Degrees)
January	9.6	290
February	9.6	300
March	10.1	310
April	9.8	180
May	8.0	180
June	7.4	180
July	6.9	180
August	6.4	180
September	6.8	180
October	7.2	180
November	9.0	180
December	9.1	180
Average	8.3	180

Source: NWS 2002.
[a]To convert from miles/hour to km/hour, multiply by 1.61.

The JPG region also is subject to tornadoes, which are most common in southeastern Indiana from May through July. A tornado occurred at JPG in 1998. The tornado path traversed the area north of the firing line, entering the installation north of F Road and exiting the installation at approximately H Road (see Figure 2-2). If the tornado followed a straight path, it would have touched down approximately 2.5 miles (4 km) north of the DU Impact Area. According to the NCDC, for the period from 1950 to 1995, an annual average of 20 tornadoes per year occurred in the State of Indiana. The annual average number of strong–violent tornadoes (F2–F5 on the Fujita scale) in Indiana is 7 (NCDC 2001).

The State of Indiana's ambient air quality standards are identical to the National Ambient Air Quality Standards. Air quality monitoring is conducted under the Indiana Department of Environmental Management's (IDEM's) Office of Air Management. JPG is located in a region that complies with both State of Indiana and Federal ambient air quality standards (IDEM 2001). During operation, JPG was not classified as a major source contributor to air pollution (U.S. Army 1995a). No emission sources are associated with the DU Impact Area.

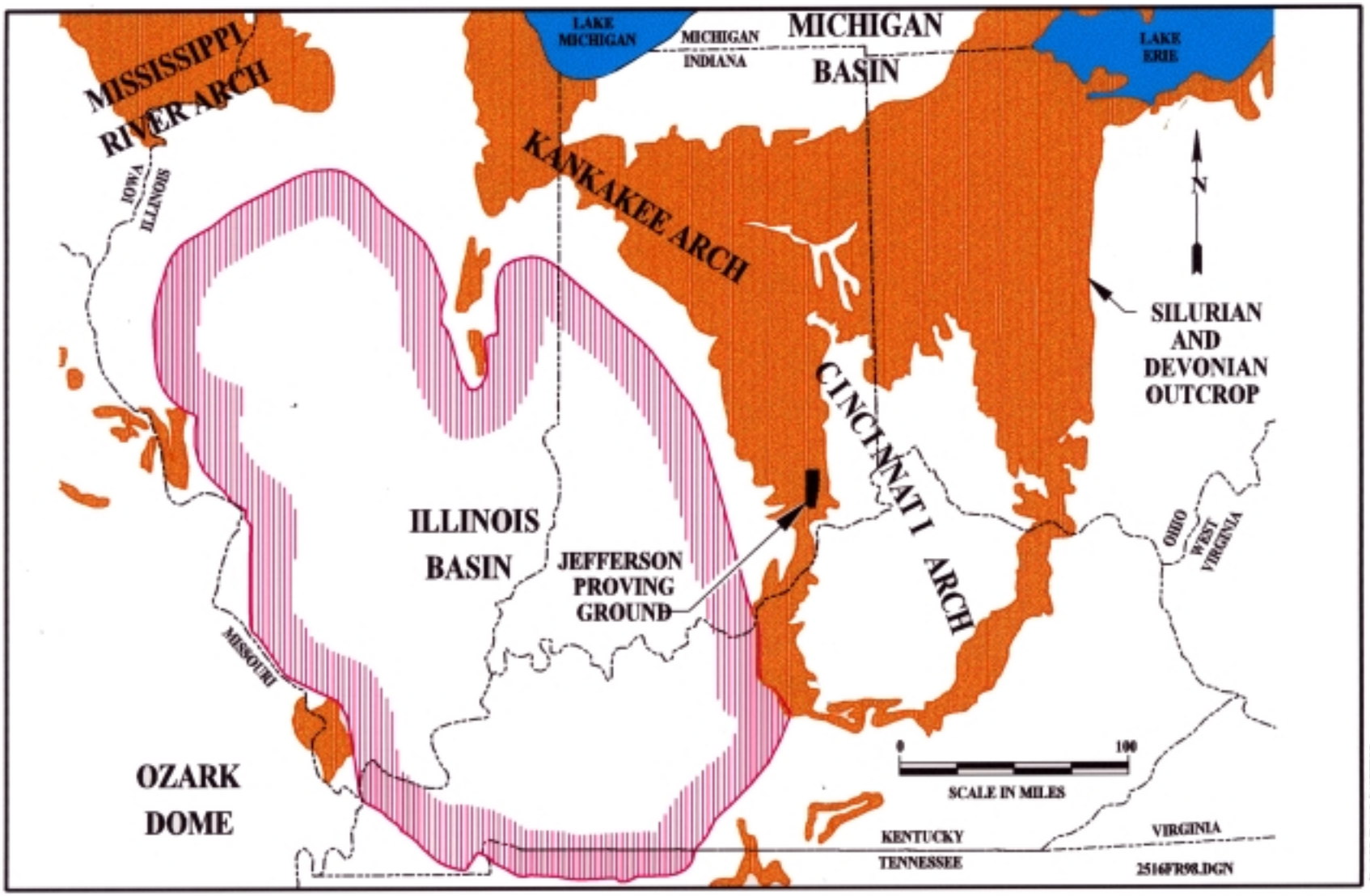
3.5 GEOLOGY, SOILS, AND SEISMOLOGY

Information on JPG's bedrock and glacial geology, soils, and seismology is provided in Sections 3.5.1, 3.5.2, and 3.5.3, respectively.

3.5.1 Geology

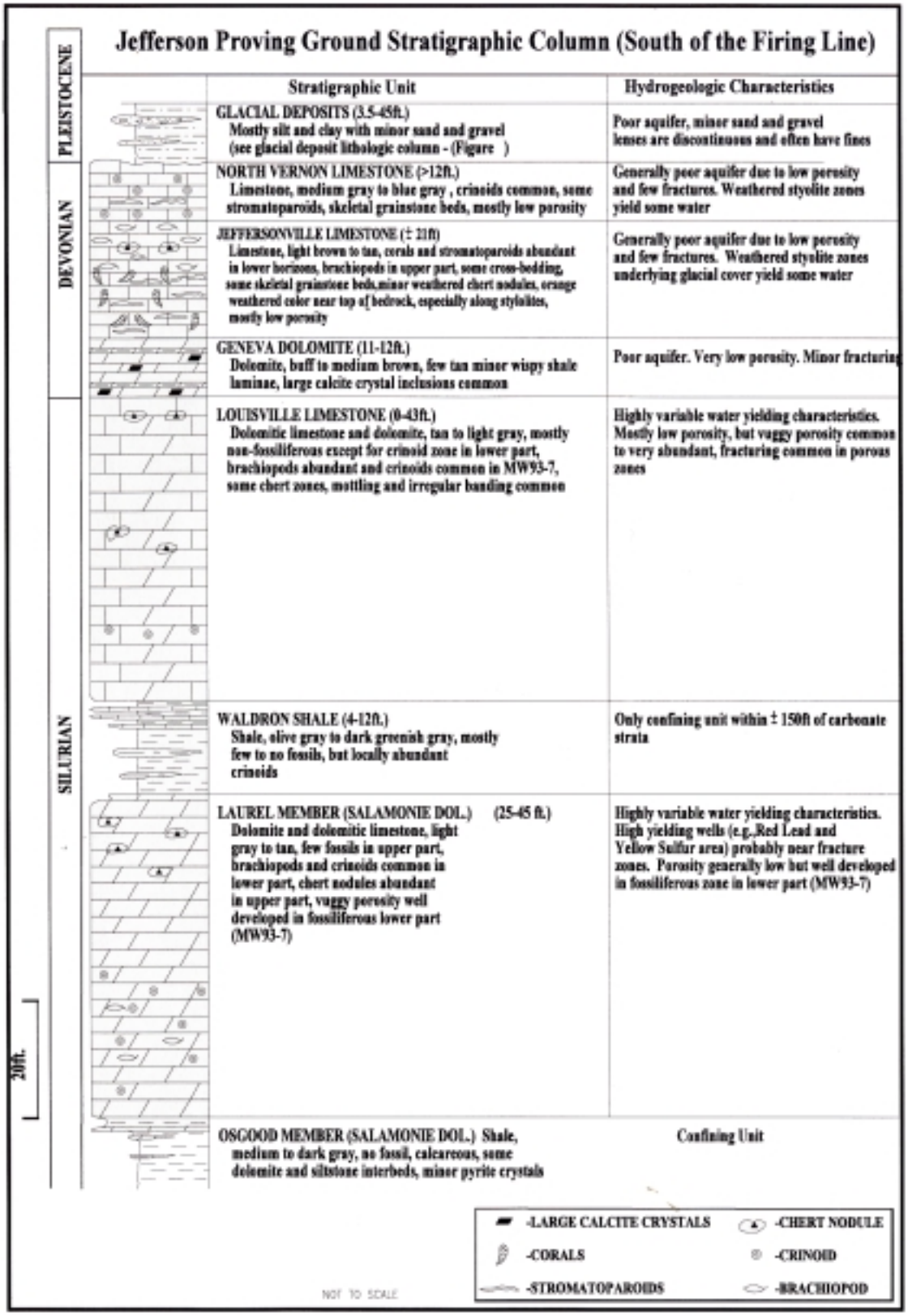
JPG is located on the western flank of the Cincinnati Arch, a broad structural feature that separates the Illinois and Appalachian Basins (Figure 3-1). Most of the installation is covered by a layer of Pleistocene glacial deposits that overlies Paleozoic bedrock. These deposits average about 25 ft (7.6 m) in thickness, and range in thickness from 3.5 to 45 ft (1.1 to 13.7 m) [Figure 3-2]. The underlying bedrock consists of interbedded limestone, dolomite, and shale.

The bedrock thickness encountered in wells drilled south of the firing line has varied from approximately 10 to 65 ft (3 to 20 m) [MWH 2002]. The thickness of the underlying bedrock formations is variable, as shown on the cross-section of the cantonment area in Figure 3-3, reflecting the installation's location on the Cincinnati Arch. For example, the Louisville Limestone has a thickness of approximately 50 ft (15.2 m) on the western edge of the installation but pinches out to the east (Figure 3-3) [MWH 2002].



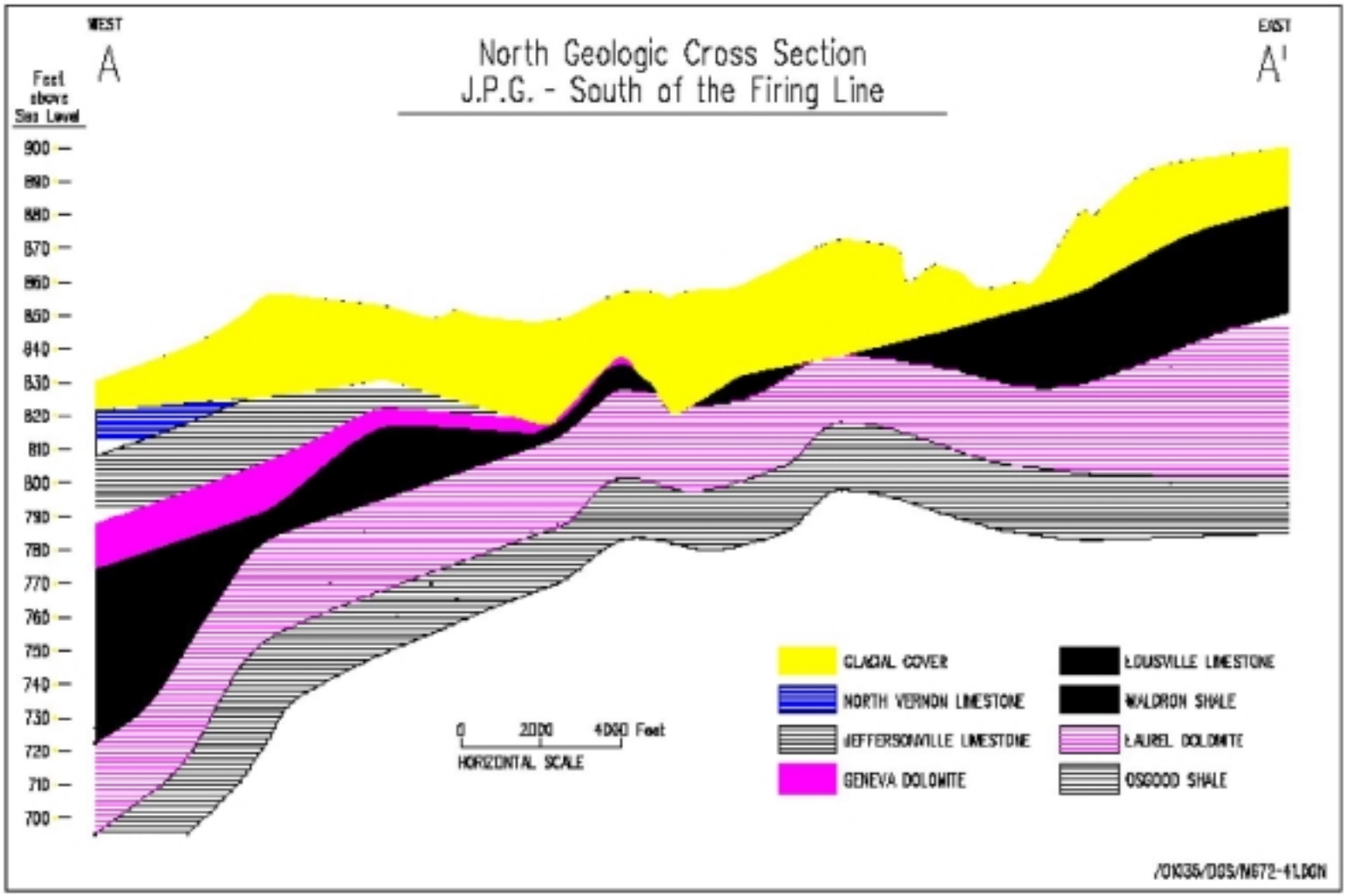
Source: MWH 2002.

Figure 3-1. Regional Structural Setting of Jefferson Proving Ground



Source: MWH 2002.

Figure 3-2. Stratigraphic Column for Jefferson Proving Ground



Source: MWH 2002.

Figure 3-3. West-East Cross-Section Across the Cantonment Area at Jefferson Proving Ground

Within the DU Impact Area, the depth to bedrock ranges from 2 to more than 19 ft (0.6 to more than 5.8 m) based on the stratigraphy in the groundwater monitoring wells in this area. The bedrock in this area is described as fine-grained, light-to-medium gray limestone with shale streaks.

The overlying glacial deposits south of the firing line consist of interbedded silts and clays, and silts with gravel, based on a review of borehole logs from wells drilled on the installation. Closer to the bedrock contact, the glacial deposits contain chert, dolomite, and limestone rock fragments overlain by silt and clay layers that contain discontinuous gravel lenses (MWH 2002).

Within the DU Impact Area, the glacial deposits are described as brown, silty clay containing some black gravel/rock fragments and some chalky white rock fragments. From the ground surface to a depth of 1 to 1.5 ft (0.3 to 0.5 m) below ground surface (BGS) has been disturbed from detonation.

3.5.2 Soils

Soils at JPG developed from glacially derived parent material. There are two major soil associations present on the installation: Cobbsfork-Avonburg and Cincinnati-Rossmoyne Hickory (Figure 3-4). The Cobbsfork-Avonburg soils are present on upland glacial drift plains characterized by smooth topography with slopes ranging from 0 to 4 percent. The nearly level Cobbsfork soils have a seasonal high water table and are located on tabular divides. Typically, these soils have surface and subsurface layers composed of grayish-brown silt loam; both layers are about 6 in. (0.15 m) thick. The Avonburg soils also have a seasonal high water table and are located in relatively broad tabular divides and upper back slopes. These soils have a low-permeability fragipan in the subsoil. These soils have a brown silt loam surface layer about 10 in. (0.25 m) thick (MWH 2002).

The nearly level and gently sloping, moderately drained Rossmoyne soils are located on summits, shoulder slopes, and upper back slopes and have a low-permeability fragipan in the subsoil. Typically, these soils have a dark brown silt loam surface layer about 8 in. (0.23 m) thick. The gently sloping to moderately sloping, well-drained Cincinnati soils are located on summits, shoulder slopes, and back slopes, and have a low-permeability fragipan in the subsoil. The dark brown surface layer is about 6 in. thick (MWH 2002).

Soils within the DU Impact Area vary depending on the location. Six different types of soils occur either on or adjacent to stream beds. These soils are described as silt loam, loam, and silty clay loam. At more inland locations, the soil type is generally deep and moderately well drained, with slopes of 0 to 35 percent, occurring mainly on the ridge tops, breaks, and hillsides. Further inland, the soil type is generally nearly level to gently sloping, somewhat poorly drained, and located on tabular divides (U.S. Army 1995a).

3.5.3 Seismology

The U. S. Geological Survey (USGS) maps of seismic hazards published in 1997, for Central and Eastern United States (CEUS) [USGS 2001a] and historical earthquakes (USGS 2002a) were reviewed to determine the potential seismic hazard for the JPG site (USGS 2001a). The number of earthquakes within a radii of 100 and 200 miles (161 and 322 km) of Modified Mercalli Intensity (MMI) IV (note that an earthquake of Richter Magnitude 4 ~ 5 is comparable to an earthquake with MMI IV ~ V) or greater over the last 100 years are listed in Tables 3-4 and 3-5. A total of 24 earthquakes of MMI IV have occurred within 200 miles of the site since 1901. No earthquakes of MMI IV have occurred within 50 miles (80 km) of the site over the last 100 years. The largest magnitude earthquake recorded was magnitude 5.5 in November 1968 at a distance of approximately 172 miles (276 km) from the site.

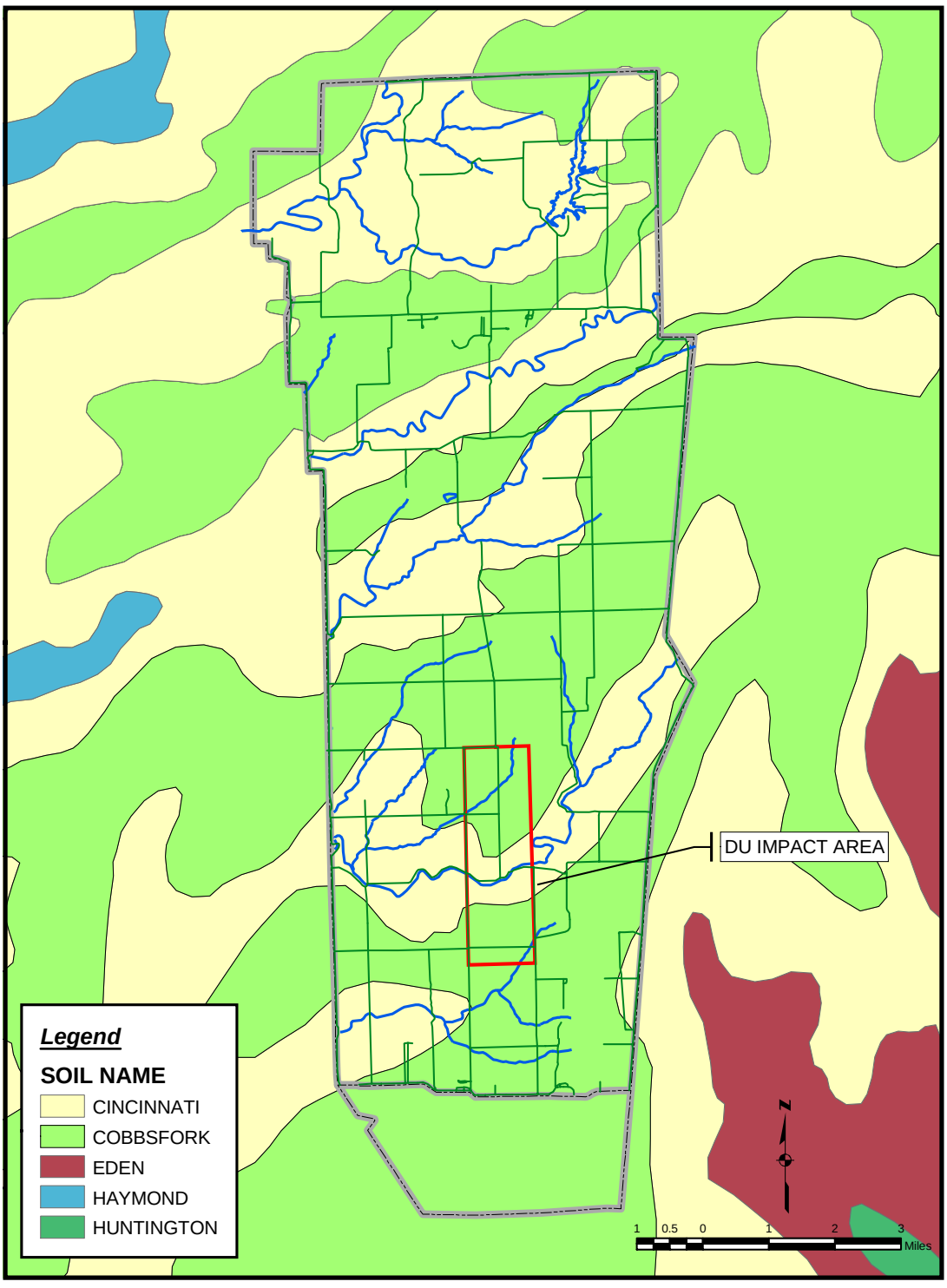


Figure 3-4. Major Soil Associations Present at Jefferson Proving Ground

Table 3-4. Historical Earthquakes within 200 Miles (332 km) of Jefferson Proving Ground, Madison, Indiana

Date	Location		Depth (km)[a]	Magnitude	Distance (km)[a]
	Latitude (degrees)	Longitude (degrees)			
May 17, 1901	38.75	–83.00	NR[b]	4.2	210
September 27, 1909	39.80	–87.20	NR	5.1	189
March 14, 1921	39.50	–87.50	NR	4.4	196
November 27, 1922	37.80	–88.50	NR	4.8	291
April 27, 1925	38.20	–87.80	NR	4.8	217
September 2, 1925	37.80	–87.50	NR	4.6	212
November 5, 1926	39.10	–82.10	NR	3.8	289
September 30, 1930	40.30	–84.30	NR	4.2	192
September 20, 1931	40.43	–84.27	5	4.7	206
March 2, 1937	40.49	–84.27	2	5.0	211
March 9, 1937	40.47	–84.28	3	5.4	209
June 20, 1952	39.64	–82.02	9	4.0	307
January 2, 1954	36.60	–83.70	NR	4.3	286
September 7, 1956	36.44	–83.79	5	4.1	297
November 8, 1958	38.44	–88.01	5	4.4	229
November 9, 1968	37.91	–88.37	21	5.5	276
April 3, 1974	38.55	–88.07	14	4.7	232
January 19, 1976	36.87	–83.86	1	4.0	254
June 17, 1977	40.71	–84.71	1	3.2	220
July 27, 1980	38.19	–83.89	6	5.1	148
June 29, 1984	37.70	–88.47	2	4.1	293
July 12, 1986	40.54	–84.37	10	4.6	213
June 10, 1987	38.71	–87.95	10	5.2	220
September 7, 1988	38.14	–83.88	10	4.6	152

Source: USGS 2002a.
[a]To convert from km to miles, multiply by 0.621.
[b]NR = Not reported.
km = kilometer.

Table 3-5. Historical Earthquakes within 100 Miles (161 km) of Jefferson Proving Ground, Madison, Indiana

Date	Location		Depth (km)[a]	Magnitude	Distance (km)[a]
	Latitude (degrees)	Longitude (degrees)			
April 12, 1791	37.40	–85.00	NR[b]	NR	159
July 27, 1980	38.19	–83.19	6	5.1	148
September 7, 1988	38.14	–83.88	10	4.6	152

Source: USGS 2002a.
[a]To convert from km to miles, multiply by 0.621.
[b]NR = Not reported.
km = kilometer.

A review of the seismicity in this area reveals that the greatest threat at the site could result from the so-called New Madrid Seismic Zone (NMSZ). The peak acceleration map for the National Earthquake Hazard Reduction Program (NEHRP) B-C Boundary, indicating seismic hazard as percent of the acceleration of gravity (g) [i.e., 9 percent g] with a probability of 5 percent of exceedance in 50 years, is shown in Figure 3-5. The Peak Ground Acceleration (PGA) hazard parameters (based on USGS 2002a) for the JPG Site are shown in Table 3-6. From this table, it is evident that earthquakes with a thousand years return period could result into a PGA of approximately 0.047g at the JPG site.

3.6 SURFACE WATER HYDROLOGY

Surface water features are abundant at the installation and include ponds, lakes, streams, and wetland areas, along with numerous ephemeral streams, ponding sites, and wet areas. Seven streams and their tributaries drain the JPG area, generally flowing from northeast to southwest, and include Otter Creek, Graham Creek, Little Graham Creek, Marble Creek, Big Creek, Middle Fork Creek, and Harberts Creek (Figure 3-6). JPG lies within the White River Drainage Basin (a sub-basin of the Wabash River Basin, which is a sub-basin of the Ohio River Basin) [U.S. Army 1995a]. Peak flow rates for surface water at JPG generally are in the spring. Typical flow rates range from 25 to 50 cubic feet per second (cfs) [0.7 to 1.4 cubic meters per second (m^3/s)].

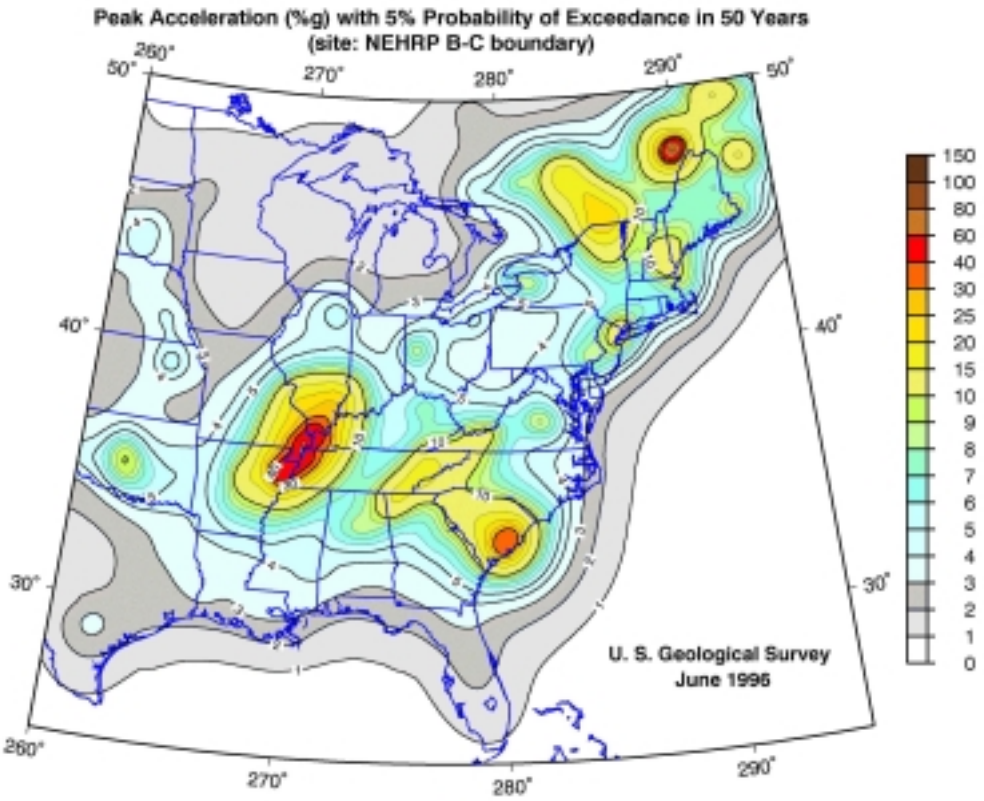
JPG is located in the Muscatatuck watershed of the White River Drainage Basin. EPA's Index of Watershed Indicators (IWI) rates the condition and vulnerability of aquatic systems in the United States. The overall IWI score for this watershed is 3, which indicates "Less Serious Water Quality Problems - Low Vulnerability to stressors such as pollutant loadings" (see http://cfpub.epa.gov/surf/huc.cfm?huc_code=05120207). Additional information is provided in the White River Basin Study (USGS 2001b).

Big Creek bisects the DU Impact Area, and Middle Fork Creek crosses the southeastern DU Impact Area boundary, as shown in Figure 3-6. Big Creek originates off-site and flows 9.2 stream miles across JPG. It is fed by numerous unnamed, intermittent tributaries and has a sandy/gravelly substrate. Middle Fork Creek originates on JPG and is fed by several unnamed intermittent tributaries. It has a gravel substrate and meanders 4.5 miles (7.2 km) across the facility, draining 6,520 acres. Information on the other five streams is provided in the Final EIS for Disposal and Reuse of the JPG (U.S. Army 1995a).

Surface water is not used as a domestic drinking water supply in the vicinity of JPG; its primary use is for recreation and livestock watering (MWH 2002). Within the Big Oaks NWR, fishing is permitted only at the 165-acre Old Timbers Lake (FWS 2001b). The streams have no segments listed in the Nationwide Rivers inventory, nor are they a part of the National Wild and Scenic Rivers System (Mason and Hanger 1992). All surface water bodies at JPG are classified as "warm-water aquatic and full-body contact" by the State of Indiana water quality standards (Clark 1993).

Flooding is common in southeastern Indiana because of the proximity to the Ohio River. One major flood has occurred along the Ohio River in southeastern Indiana since 1998. Heavy rains also may cause the tributaries of the Ohio River that cross JPG (i.e., Big Creek) to swell (MWH 2002).

At least 10 ponds or lakes that vary in size from less than 1 acre to 165 acres (0.004 to 0.7 km^2) are located on the installation. No ponds or lakes are located in the DU Impact Area. The impoundment of Little Otter Creek by little Otter Dam formed Old Timber's Lake, and a dam on Harbert's Creek formed Krueger Lake. Both lakes are used for recreational purposes. There is no significant commercial value associated with the water bodies. Old Timbers Lake in the northeast corner of the site has an area of 165 acres. Krueger Lake is in the southeast portion of the site and has an area of 8 acres. No other



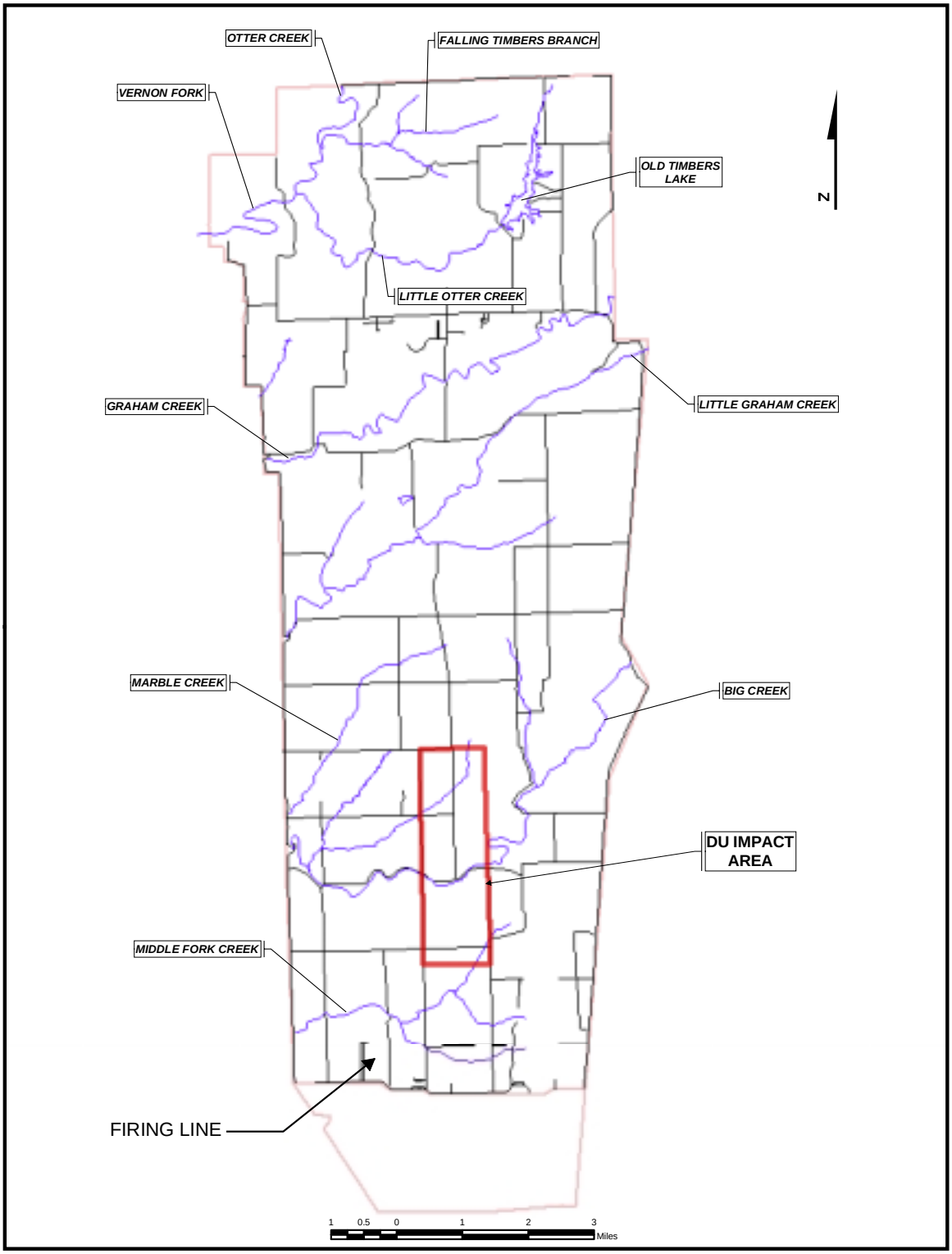
Source: USGS 2001a.

Figure 3-5. Peak Acceleration With a Probability of 5 Percent of Exceedance in 50 Years

Table 3-6. Seismic Hazard Curve for Jefferson Proving Ground, Madison, Indiana

Acceleration (%g)	Frequency of Exceedance (dimensionless)
0.0050	2.456×10^{-2}
0.0070	1.688×10^{-2}
0.0098	1.121×10^{-2}
0.0137	7.226×10^{-3}
0.0192	4.510×10^{-3}
0.0269	2.736×10^{-3}
0.0376	1.612×10^{-3}
0.0527	9.083×10^{-4}
0.0738	4.880×10^{-4}
0.1030	2.497×10^{-4}
0.1450	1.189×10^{-4}
0.2030	5.523×10^{-5}
0.2840	2.539×10^{-5}
0.3970	1.182×10^{-5}
0.5560	5.535×10^{-6}
0.7780	2.568×10^{-6}
1.0900	1.139×10^{-6}
1.5200	4.782×10^{-7}
2.1300	1.818×10^{-7}

Source: Based on USGS 2002a.
g = Gravity.



Source: MWH (2002).

Figure 3-6. Surface Water Drainage at Jefferson Proving Ground, Madison, Indiana

man-made water control structures are anticipated for the site. It has been noted that a growing beaver population has led to the creation of significant acreage of ponds and marsh areas, some within the DU Impact Area.

Water quality, biological, and physical data available on EPA's STORET (short for STOrage and RETrieval) do not include any of the streams on JPG. Surface water sampling data involving total uranium concentrations are available for Big Creek and Middle Fork Creek and are discussed in Section 4.3 of this report. There are no surface water or subsurface uses (e.g., withdrawals, consumption, or returns) currently within the installation boundaries. There is no evidence of past, current, or future pollutant sources with discharges to water in the area north of the firing line, which includes the DU Impact Area (U.S. Army 1995a; Mason and Hanger 1992). Detailed flow information on these streams (e.g., historic monthly flow information, drought stages and discharges by month, and short-duration flow fluctuations) is not available for the JPG streams. Current Federal Emergency Management Agency data (see http://www.fema.gov/mit/tsd) indicate that JPG is not located within a floodplain.

3.7 GROUNDWATER HYDROLOGY

In this section the hydrostatic units are described (Section 3.71). Groundwater use and off-site groundwater wells are identified in Sections 3.7.2 and 3.7.3, respectively.

3.7.1 Hydrostatic Units

Three hydrostratigraphic units are located in the JPG area. The unconsolidated glacial deposits underlying the site form one unit. The Paleozoic limestones and dolomites that underlie the unconsolidated glacial deposits form a second unit. The third hydrostratigraphic unit consists of the alluvial deposits in the Ohio River Valley south of the installation.

Unconsolidated Glacial Deposits

The unconsolidated glacial deposits range in thickness from 4 to 43 ft (1.2 to 13.1 m) south of the firing line and are composed predominantly of glacial till (MWH 2002). The hydraulic conductivity of the till ranges from 1.1×10^{-5} to 3.3×10^{-5} in./sec [2.9×10^{-5} to 8.4×10^{-5} centimeters per second (cm/sec)] based on slug tests in wells (Rust E&I 1998; MWH 2002). The direction of groundwater flow is roughly the same as the surface water drainage, which is to the west–southwest over most of the installation. The matrix hydraulic conductivity of the tills at JPG ranges from 1.3×10^{-5} to 3.9×10^{-5} in./sec (3.4×10^{-8} cm/sec to 9.8×10^{-8} cm/sec) [MWH 2002]. Small-scale fractures and sand lenses within the till contribute to the higher hydraulic conductivity measured by the slug tests.

Silurian and Devonian Limestones and Dolomites

The shallow bedrock groundwater in the vicinity of JPG is stored primarily in the bedrock hydrostratigraphic unit comprised of Silurian and Devonian limestones and dolomites members. The aquifer is unconfined to semi-confined and is recharged by infiltration of precipitation to the bedrock aquifer concentrated along fractures within the glacial till and in areas where the creek channels are losing water to the groundwater system. Groundwater in the bedrock shows a direct and rapid response to changing climatic conditions (MWH 2002).

Groundwater flow in the bedrock aquifer is controlled primarily by fractures. The bedrock aquifer is unconfined and recharged by surface water flow. In areas where the overlying till is not fractured, the groundwater in the bedrock aquifer appears to be confined. Cores of limestone bedrock from the site contained fractures 3.94×10^{-3} in. (100 µm) or larger and showed evidence of solutioning (MWH 2002).

Karst features, such as sinkholes, have been recognized along the Otter Creek and Big Graham Creek drainages a few miles west of JPG; however, no karst features have been mapped at JPG (MWH 2002).

A karst study to identify caves was conducted at the installation from 1994 to 1997 along five creeks: Big Creek, Middle Fork Creek, Graham Creek, Little Graham Creek, and Otter Creek (Sheldon 1997). During this inventory, 32 caves with 52 entrances were identified. The cave lengths ranged from approximately 26 ft (7.9 m) to the longest cave length of 1,507 ft (459 m). Nineteen caves were identified along Big Creek, with an average cave length of approximately 162 ft (49.4 m).

The water-level elevations of wells screened in bedrock loosely conform to the configuration of the surface topography. The direction of groundwater flow in bedrock generally is to the west−southwest. The water level elevations measured in the DU Impact Area are variable, ranging from a minimum of 3 ft below the surface in monitoring well (MW)-10 to a maximum of 32 ft (9.8 m) below the surface in MW-09 (refer to Figure 3-2 for well locations) [U.S. Army 2001]. The variability in the depth to groundwater may reflect the occurrence of fractures in bedrock. Table 3-7 provides data for the DU Impact Area groundwater monitoring wells (SEC Donahue, Inc. 1992). Figure 3-7 shows the potentiometric contours based on these data. The wells are too widely spaced to interpret the potentiometric surface or identify preferred flow paths. It appears, however, that in the vicinity of incised surface drainages, the potentiometric surface slopes toward the streams at roughly the same gradient as the surface topography. Therefore, on a local scale, the bedrock groundwater tends to discharge to surface streams (SEC Donahue, Inc. 1992).

Slug and pump tests were completed on 51 wells located south of the firing line screened in the bedrock aquifer. The hydraulic conductivity of the bedrock aquifer computed from slug tests ranges from 0.67×10^{-5} to 2.3×10^{-4} in./sec (1.7×10^{-5} to 5.8×10^{-4} cm/sec) [MWH 2002]. The pumping test results indicate hydraulic conductivities ranging from 0.55×10^{-4} to 2.4×10^{-3} (1.4×10^{-4} cm/sec to 6×10^{-3} cm/sec) [MWH 2002].

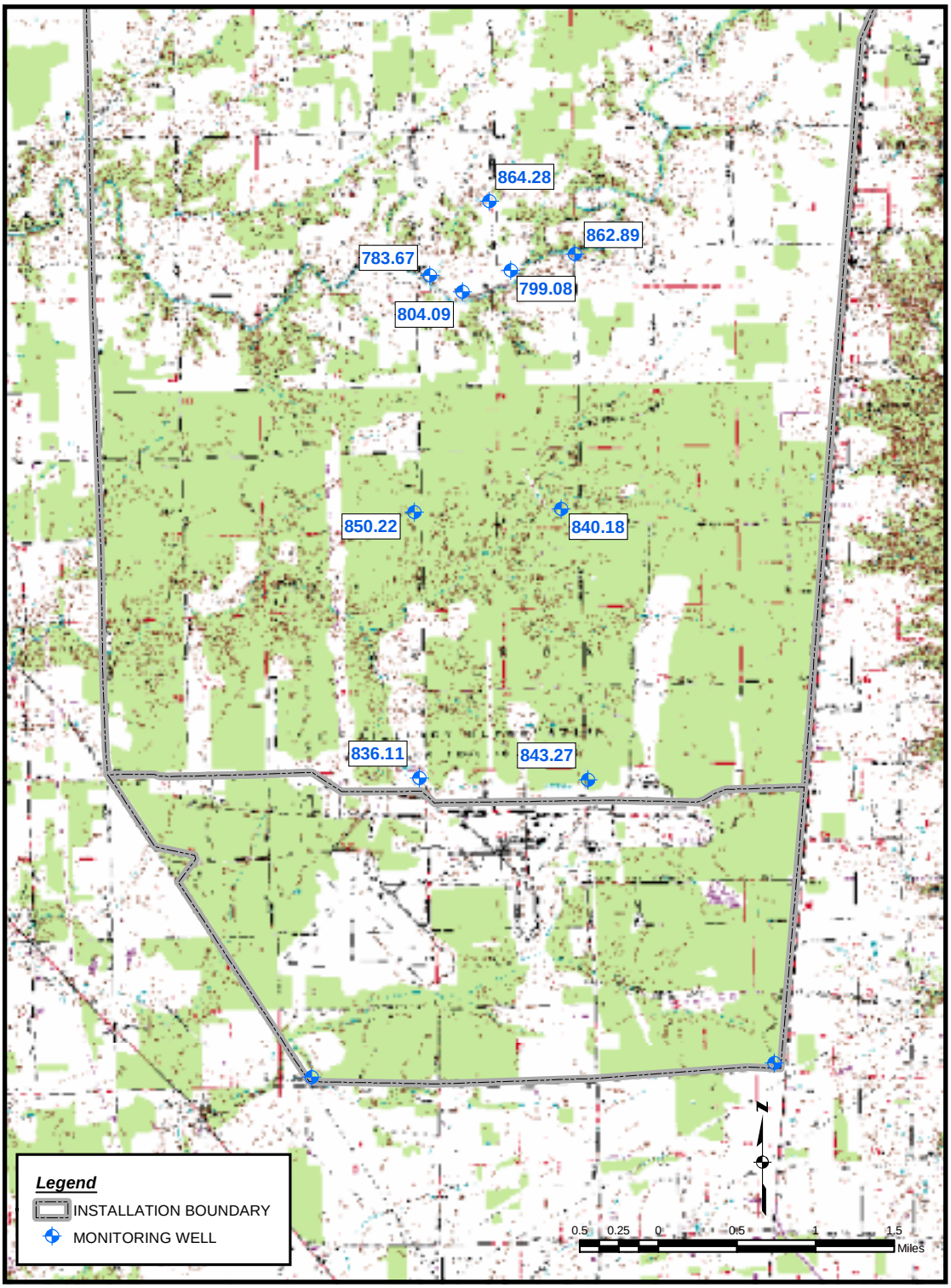
Ohio River Alluvial Deposits

The third hydrostratigraphic unit, the Ohio River Valley alluvium, does not underlie the site and is significant because it is the only major source of groundwater in the region that is available for domestic use (MWH 2002). However, the closest location of this unit is approximately 5 miles (8 km) south of JPG. Because the bedrock groundwater flow direction at JPG generally is to the southwest, and the north−south stream drainages are located west of JPG, it is unlikely that potential contamination present at JPG could reach the Ohio River alluvial aquifers. The southwest groundwater flow direction at JPG is in agreement with the regional groundwater flow direction documented in the USGS Open File Report 90-151 (see Figure 3-8) [Bugliosi 1990].

Table 3-7. DU Impact Area – Groundwater Monitoring Wells

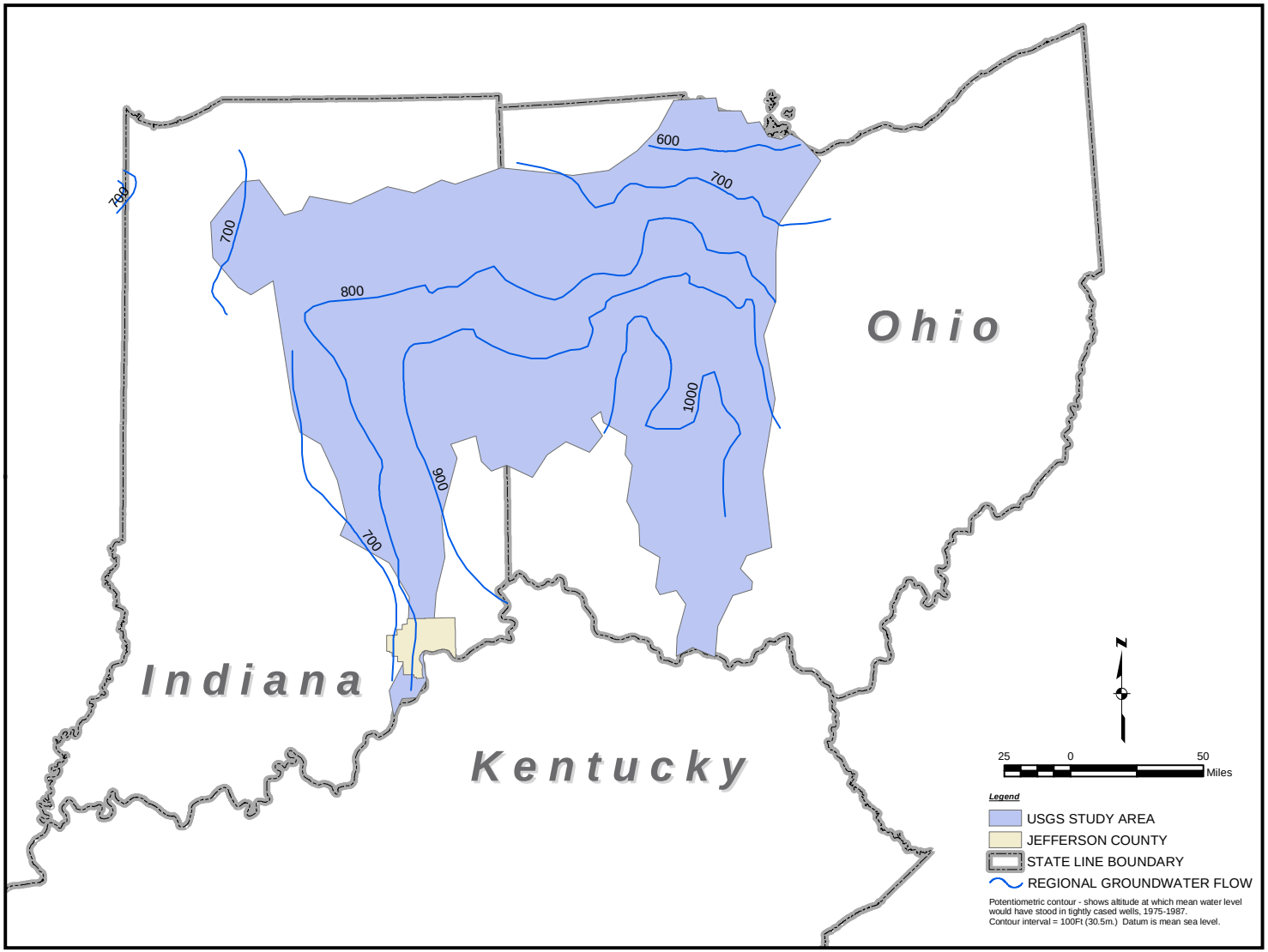
Well No.	Date Completed	Total Depth (ft)[a]	Depth to Bedrock (ft)[a]	Water Level Depth[b] (ft Below Ground Surface)	Comment
1	12/6/83	33.2	4.5	10	1.5 feet (ft) disturbed by detonation. Fire-granted gray limestone. Loss of recirculation water near 8 ft.
2	12/13/83	23.7	7	10	1.5 ft disturbed by detonation. Fractured gray to brownish-gray limestone. Loss of recirculation water near 14.8 ft. Large solution cavities and shaley-clay-filled voids.
3	12/13/83	4.3	18.5	8	1.5 ft disturbed by detonation.
4	12/14/83	28.5	10	3	
5	12/7/83	33.4	20.3	5.6	1 ft disturbed by detonation.
6	12/17/83	40	NA	18.25	1.5 ft disturbed by detonation. No bedrock encountered.
7	12/8/83	53.7	26.5	8.8	
8	12/9/83	28.2	14.5	23	Loss of recirculation water at 20 ft.
9	9/18/88	38.2	3.7	32	
10	9/18/88	41.3	NA	3	No bedrock encountered. Borehole encountered glacial till.
11	9/19/88	41.9	2	6.8	Limestone with horizontal solution features. Solution cavities filled with sediment.

Source: SEC Donahue, Inc. 1992.
[a]To convert feet to meters, multiply by 0.3.
[b]Groundwater levels from borehole drilling logs.
NA = Not applicable.



Source: SEC Donahue, Inc. 1992.

Figure 3-7. Groundwater Contours of the DU Impact Area



Source: Bugliosi 1990.

Figure 3-8. Regional Groundwater Flow Direction for the Cincinnati Arch

3.7.2 Groundwater Use

There are no sole source aquifers on or in the vicinity of JPG based on a review of EPA Region 5's sole source aquifer designations (EPA 2002). A sole source aquifer is an aquifer designated by EPA as the sole, or principal, source of drinking water for a given area (i.e., an aquifer that supplies 50 percent or more of the area), and for which there is no reasonable alternative should the aquifer become contaminated.

The groundwater under JPG generally is of poor quality and is not used for drinking purposes or for other purposes in any significant capacity. The drinking water at JPG is obtained from the City of Madison Municipal Supply Systems and the Canaan Deposits in the Ohio River Valley, approximately 5 miles (8 km) from JPG (MWH 2002).

3.7.3 Off-site Groundwater Wells

A review of the State of Indiana records of groundwater wells drilled off-site in a downgradient direction indicated that nine groundwater wells completed in bedrock had been drilled from 1945 to 1966 for domestic and stock use. Table 3-8 summarizes water wells identified by an online search of the Indiana Department of Natural Resources (IDNR) well data files. It is unknown if these wells currently are operational. The closest well location is approximately 4 miles (6.4 km) southwest of the DU Impact Area. The Draft Final RI provides additional information on wells in Jennings, Ripley, and Jefferson Counties (MWH 2002).

3.8 NATURAL RESOURCES

The primary natural resources occurring at or near the site are timber from the wooded area of the site. The JPG is 75 percent forested, primarily with hardwoods, and, to a lesser extent, coniferous trees. The species of potential commercial value are white oak and black walnut. Groundwater at the site is considered non-potable because the water has high total dissolved solids and is of poor quality and low productivity (MWH 2002). Water used at the site is supplied by the Madison, Indiana, municipal water supply system for areas south of the firing line and by other municipal water supply system(s) [i.e., Canaan Water Company] for areas off of the facility but north of the firing line. No drinking water wells, or municipally supplied water, are available north of the firing line on the facility. Canaan Water Company supplies potable water for Old Timbers Lodge when it is operational.

3.9 ECOLOGY/ENDANGERED SPECIES

JPG provides quality habitat for a variety of terrestrial and aquatic species. Forty-one species of fish, 8 species of freshwater mussels, 24 species of amphibians, and 18 species of reptiles have been found on the installation. Mammal species include white-tail deer, raccoon, coyote, opossum, gray and fox squirrel, skunk, beaver, red fox, weasel, and mink. Large populations of small mammals, including mice and moles, attract significant numbers of reptiles and raptors. JPG is approximately 80 percent reforested, and the unbroken stands of mature and young trees are used by migrating neo-tropical birds. More than 100 breeding birds have been recorded at the installation. The American Bird Conservancy has listed the Big Oaks NWR as a Globally Important Bird Area because of its importance to grassland birds (e.g., Henslow's sparrow) and forest birds (e.g., cerulean warbler). The FWS and the Institute for Bird Populations are conducting ongoing census surveys of wildlife at the installation. Wildlife management continues even with the JPG's closure in September 1995. Twenty-five river otters were released in January 1996 at the Old Timbers Lake in support of Indiana's Otter Restoration Program (SAIC 1997a). Six additional otters were released into Otter Creek at Blue Hole on January 31, 1999 (SAIC 2002b).

Table 3-8. Groundwater Wells Located Outside of the JPG boundaries and Downgradient of the DU Impact Area

Township	Range	Section	Reference Number	Well Depth (ft)[a]	Depth to Bedrock (ft)[a]	Formation	Static Water Level (ft)[a]	Well Use	Install Date	Status
5N	9E	10	220845	189	Unknown	Unknown	11	Home	Unknown	Unknown
5N	9E	10	220850	78	Unknown	Limestone	11	Home	1945	Unknown
5N	9E	11	220873	85	20	Limestone	10	Home	1960	Unknown
5N	9E	11	220878	80	10	Grey and Blue Limestone	Unknown	Home	1960	Unknown
5N	9E	15	220868	111	17	Limestone	17	Home	1966	Unknown
5N	9E	23	220843	60	35	Hard Blue Limestone	15	Stock	1960	Unknown
5N	9E	34	220811	78	15	Blue Shale and White Lime	27	Home	1966	Unknown
5N	9E	34	220816	96	15	Blue Stone or Soapstone	14	Home	1964	Unknown
5N	9E	34	220821	285	16	Limestone	Unknown	Home	1963	Unknown

Source: IDNR 2001a.
[a]To convert from feet to meters, multiply by 0.3.

JPG provides habitat for a wide variety of game animals and fish that are harvested on the installation. Until the early 1990s, there was some stocking of game birds, fish, and other creatures to maintain stable populations of some species. Hunting is allowed on approximately 27,700 acres (112 km^2). The remaining area, approximately 27,300 acres (110 km^2), provides habitat for small game; however, this land is closed to hunters because of the presence and hazards of UXO and DU. The staff of the Big Oaks NWR manage the hunting program at JPG (FWS 2001b).

White-tailed deer and wild turkey hunting is permitted in designated areas administered by the FWS as part of the Big Oaks NWR (FWS 2001b). Mammals and fowl harvested on JPG include white-tail deer, fox squirrel, eastern gray squirrel, eastern cottontail rabbit, and wild turkey. Approximately 400 to 500 whitetail deer are harvested annually (FWS 2001b). The wild turkey harvest averages 50 birds per year (MWH 2002). Permit-drawn hunts for the general public have been conducted for deer since the 1960s and for turkey since 1984. Fish harvested on JPG include bass, bluegill, sunfish, crappie, and catfish.

There are 11 federally endangered animals (3 birds, 1 mammal, and 7 mollusks) that may occur within the boundaries of JPG. The three bird species are transients that may be present during migration, including the Piping plover (*Charadrius melodus*), Kirtland's warbler (*Dendroica kirtlandi*), and interior least tern (*Sterna antillarum athalassos*). The Indiana bat (*Myotis sodalis*) also has been documented at JPG (Rust E&I 1998). The white catspaw (*Epioblasma obliquata perobliqua*), northern riffleshell (*Epioblasma torulosa rangiana*), tubercled blossom (*Epioblasma torulosa torulosa*), pink mucket (*Lampsilis abrupta*), ring pink (*Obovaria refusa*), orange-foot pimpleback (*Plethobasus cooperianus*), and fat pocketbook (*Potamilus capax*) are all federally endangered mollusks. The bald eagle (*Haliaeetus leucocephalus*) is the only federally threatened animal (IDNR 2001b). Table 3-9 identifies Federal, State of Indiana, and Carroll and Trimble Counties, Kentucky, endangered species.

In addition to the 11 federally endangered species, 9 State of Indiana-endangered species (6 birds, 2 mammals, and 1 reptile) and 2 Carroll and Trimble County, Kentucky, endangered species (2 mollusks) also have been identified. Additionally, Henslow's sparrow (*Ammodramus henslowii*) has been identified as a breeding species at JPG. Ten species in Indiana and five species in Kentucky are listed as species of special concern [IDNR 2001b; Kentucky State Nature Preserves Commission (KSNPC) 2001].

Table 3-9. Federal and State Endangered Species

Species Type	Species Name	Common Name	Status
Bird	*Charadrius melodus*	Piping plover	FE
Bird	*Dendroica kirtlandii*	Kirtland's warbler	FE
Bird	*Sterna antillarum athalassos*	Interior least tern	FE, INE
Mollusk	*Epioblasma obliquata perobliqua*	White catspaw	FE
Mollusk	*Epioblasma torulosa rangiana*	Northern riffleshell	FE
Mollusk	*Epioblasma torulosa torulosa*	Tubercled blossom	FE
Mollusk	*Lampsilis abrupta*	Pink mucket	FE, KYE
Mollusk	*Obovaria retusa*	Ring pink	FE, KYE
Mollusk	*Plethobasus cooperianus*	Orangefoot pimpleback	FE, KYE
Mollusk	*Potamilus capax*	Fat pocketbook	FE, INE
Mammal	*Myotis sodalis*	Indiana bat	FE, INE
Bird	*Haliaeetus leucocephalus*	Bald eagle	FT

Table 3-9. Federal and State Endangered Species (Continued)

Species Type	Species Name	Common Name	Status
Bird	*Aimophila aestivalis*	Bachman's sparrow	INE
Bird	*Ammodramus henslowii*	Henslow's sparrow	INE
Bird	*Asio flammeus*	Short-eared owl	INE
Bird	*Circus cyaneus*	Northern harrier	INE
Bird	*Falco peregrinus*	Peregrine falcon	INE
Bird	*Tyto alba*	Barn owl	INE, KYSC
Mammal	*Lutra Canadensis*	River otter	INE
Mammal	*Lynx rufus*	Bobcat	INE
Mammal	*Nycticeius humeralis*	Evening bat	INE
Mammal	*Taxidea taxus*	American badger	INE
Reptile	*Clonophis kirtlandii*	Kirtland's snake	INE
Mollusk	*Lampsilis ovata*	Pocketbook	KYE
Mollusk	*Pleurobema pyramindatum*	Pyramid pigtoe	KYE
Bird	*Ixobrychus exilis*	Least bittern	KYT
Mollusk	*Simpsonaias ambigua*	Salamander mussel	KYT
Amphibian	*Necturus maculosus*	Mudpuppy	INSC
Bird	*Accipiter striatus*	Sharp-shinned hawk	INSC
Bird	*Buteo lineatus*	Red-shouldered hawk	INSC
Bird	*Buteo platypterus*	Broad-winged hawk	INSC
Bird	*Dendroica cerulea*	Cerulean warbler	INSC
Bird	*Helmitheros vermivorus*	Worm-eating warbler	INSC
Bird	*Mniotilta varia*	Black-and-white warbler	INSC
Bird	*Wilsonia citrina*	Hooded warbler	INSC
Mammal	*Condylura cristata*	Star-nosed mole	INSC
Mammal	*Mustela nivalis*	Least weasel	INSC
Amphibian	*Rana Pipiens*	Northern Leopard Frog	KYSC
Bird	*Ardea herodias*	Great Blue Heron	KYSC
Bird	*Riparia riparia*	Bank swallow	KYSC
Mollusk	*Plethobasus cyphyus*	Sheepnose	KYSC

Sources: IDNR 2001a and KSNPC 2001.
FE = Federally Endangered.
FT = Federally Threatened.
INE = Indiana Endangered.
INSC = Indiana Special Concern.
KYE = Carroll and/or Trimble County, Kentucky Endangered.
KYSC = Carroll and/or Trimble County, Kentucky Special Concern.